Astro Digital US, Inc.
3171 Jay St
Santa Clara, CA 95054

August 14, 2019

Secretary
Office of the Secretary
Federal Communications Commission
445 Twelfth Street, S.W.
Washington, D.C. 20554

Subject: IB Docket No. 18-313

To whom it may concern,

At the request of the International Bureau Satellite Division ("Bureau") and in an abundance of caution, Astro Digital US, Inc. ("Astro Digital") hereby submits this letter in the above-referenced proceeding providing notice of an August 12, 2019 meeting among representatives of Astro Digital, Apollo Fusion, Inc. ("Apollo Fusion"), and the Bureau. The following individuals participated in the meeting: Chris Biddy, CEO of Astro Digital; Jan King, CTO of Astro Digital (by phone); Tony Lin, outside counsel for Astro Digital; Mike Cassidy, CEO of Apollo Fusion; Maureen Haverty, COO of Apollo Fusion; and Bill Wiltshire, outside counsel for Apollo Fusion. Additionally, the following individuals participated in the meeting on behalf of the Bureau: Jose Albuquerque, Division Chief; Paul Blais, System Analysis Branch Chief (by phone); Stephen Duall, Policy Branch Chief (by phone); Joe Hill, Engineering Branch; Karl Kensinger, Deputy Division Chief (by phone); and Kerry Murray, Deputy Division Chief.

As part of the meeting, the participants discussed matters raised in a filing submitted in the above-referenced proceeding,[1] and Astro Digital and Apollo Fusion stated their position that those matters are beyond the scope of the proceeding. Attached is a redacted copy of the presentation made at the meeting. The redacted portion of the presentation is subject to a request for confidential treatment submitted in another proceeding.[2]

The attached document also includes two additional slides, not presented at the meeting, that highlight the importance of the mission to a number of government agencies supporting the mission (slide 14 attached) and emphasize that the authorities at the Vandenberg Air Force Base completed an applicable environmental assessment and found that launch of this and similar missions from the base would qualify for categorical exclusion determination (CATEX) A2.3.7 (slide 15 attached).

[1] *See* Letter from Public Employees for Environmental Responsibility to Marlene H. Dortch (November 19, 2018).
[2] A copy of the request for confidential treatment was previously submitted in the instant proceeding. *See* Letter from Chris Biddy, Astro Digital, to Marlene H. Dortch, FCC (July 15, 2019).

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Please contact the undersigned if you have any questions.

Sincerely,

/s/

Chris Biddy

Attachment

cc: Jose Albuquerque
Paul Blais
Stephen Duall
Joe Hill
Karl Kensinger
Kerry Murray

Ignis Mission Brief - 0330-EX-CN-2019

August 12, 2019 – FCC

Chris Biddy – chris@astrodigital.com

Mike Cassidy – mike@apollofusion.com

Outline

- Brief company introductions
- Ignis mission description
- ACE thruster background
- Mission considerations
- Environmental consideration
- Summary

Astro Digital background

- Founded in 2014 to develop the Landmapper constellation
- Expanded Payload and Platform Technology to Support a Variety of Remote Sensing, LEO Communications Missions and in-orbit demonstrations
- Headquartered in Santa Clara CA, with a 14,000 ft^2 manufacturing Facility
- 26 Employees, 20 Member Technical Staff
- 5 satellites currently under operations

Apollo Fusion background

- California electric propulsion company
- New technology 3x better than current propulsion systems on the market
- NASA JPL contract to manufacture MaSMi thruster; delivering 3 this summer
- Exclusive commercial license to industrialize NASA JPL 1,000W thruster

Apollo Fusion Team has deep expertise in Hall thrusters and plasma physics

Founded	2016
Team previous organizations	NASA, Google, Apple, SpaceX, Aerojet Rocketdyne, Tesla, Riverside Research, SSL, OneWeb
Technical expertise & experience	Propulsion, Aerospace System Engineering, Space Equipment Qualification, Materials Science, High Hazard Industries, High Reliability Industries, Radiation

20	Team members
14	Full time employees
5	PhD's
6	Former Googlers
15	Propellants tested by team members

Ignis Mission Overview

- Electric Propulsion demonstration mission
  - Small Satellite Hall effect propulsion system in-orbit validation
  - Mass, volume and power efficiency are key features
  - Critical technology for orbital maneuvers including collision avoidance and end of life de-orbit – mission enabling technology
- Astro Digital is the satellite bus manufacturer and operator
- Apollo Fusion is the propulsion system manufacturer
- Application number: 0330-EX-CN-2019
- File Date: April 19, 2019
- Initial planned launch date: Q4 2019

Mission Considerations

The Ignis mission will be operated responsibly

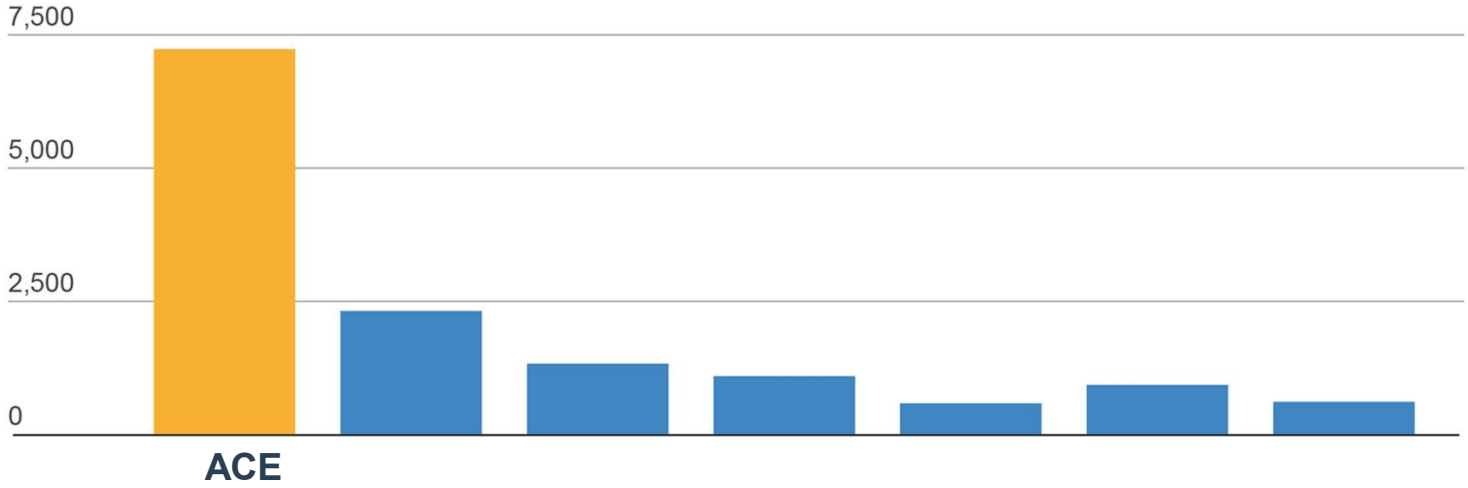
- All planned propulsive maneuvers decrease orbital lifetime
- ODAR analysis predicts a passive decay and re-entry in less than 5 years
- Mission related environmental regulations have been rigorously addressed
- TT&C frequencies have been coordinated on previous Astro Digital missions
- Important mission to multiple Air Force orgs (SMC, AFRL, DIU)

ACE thruster overview

Apollo Constellation Engine (ACE)

- Innovative Hall thruster
- Typically 1km/s delta-V for a 150kg satellite
- 3X better impulse per mass and impulse per volume
- Low storage pressure (15 psia) way safer for orbital debris

Significant improvements for impulse vs. mass and volume



Total impulse (Ns) divided by system mass (kg) for 120kg satellite with 2 thrusters & propellant

Mission Considerations

- **Environmental Context**
  - [redacted]
  - [redacted]
  - [redacted]
  - [redacted]

- **Ignis mission**
  - Mission: **minimal atmospheric emissions, propellant exhaust velocity > earth escape velocity**
  - Total propellant mass = **1.2 kg**
    - [redacted]
    - [redacted]
  - Various agencies are addressing NEPA concerns. FAA and Range Safety review Environmental Assessment of the launch. [redacted]

Sources:

[redacted]

Environmental Considerations

Apollo Fusion and Astro Digital have addressed environmental regulations and compliance for the full life-cycle of the Ignis system

- **Transportation** –
  - Apollo Fusion has obtained DOT approval for planned shipping of the integrated/fueled satellite
- **Storage/Handling** –
  - Apollo Fusion complies with EPA and OSHA storage/handling regulations
  - Apollo Fusion personnel perform all fueling and propulsion system integration
  - Apollo is registered with the EPA
- **Operation (Emissions)** –
  - Apollo Fusion complies with all EPA emissions regulations for storing, handling, and fueling the satellite on the ground
  - Analysis confirms compliance with EPA emissions regulations (even anomalous in-orbit events). Apollo Fusion has coordinated with federal launch range personnel for environmental compliance.

Environmental Considerations

1) Any International Treaties to consider?

2) Does the NEPA process apply?

[redacted]

- We believe our mission complies with all EPA regulations

National Environmental Policy Act (NEPA)

- Apollo Fusion requested permission to launch from Vandenberg Air Force Base
- Under VAFB's NEPA responsibilities, VAFB requested that Apollo Fusion complete its Environmental Impact Analysis.
- The Environmental Impact Analysis considered: Apollo Fusion's design, concept of operations, [redacted].
- The analysis was assessed by VAFB considering the potential impact on all NEPA-mandated areas: Wilderness Area, Wildlife Preserve, Endangered Species, Historic Property, Indian Religious Site, Floodplain, etc.
- The assessment found that launch [redacted] from Vandenberg qualifies for CATEX A2.3.7: proposed launch falls within current EIS and no further environmental analysis is required under NEPA.

Summary

- Ignis mission – EPA and OSHA regulations addressed
- A U.S. Air Force launch site (Vandenberg) determined action qualifies for Categorical Exemption (CE) – no further environmental impact analysis required
- Minimal atmospheric emissions under nominal Ignis mission conditions
- Responsible mission – passive de-orbit <5 years
- UHF TT&C frequencies have been coordinated with NOAA and NASA on previous Astro Digital missions

Backup Slides

August 12, 2019 - FCC

Air Force Interest in Ignis Mission

Air Force Research Lab (AFRL) support letter

> "AFRL is interested in this technology… since ACE's compact size and dense propellant enables exceptionally high delta-v missions in small satellites… [This] technology demonstration mission is of obvious interest… ACE flight heritage will substantially reduce the risk of using this system…"

Defense Innovation Unit (DIU) & Air Force Space and Missile Command (SMC) contract

> "This experiment seeks to evaluate the performance of the ACE Thruster ... on-orbit, while undergoing testing necessary for the advancement of the best supplies that are needed for national defense."

NEPA - Categorical Exemption

Completed Environmental Assessment of launch activities at Vandenberg Air Force Base. 30th Space Wing assessors found that AFI launch qualified for Categorical Exclusion determination (CATEX) A2.3.7 which states:

"A2.3.7. Continuation or resumption of pre-existing actions, where there is no substantial change in existing conditions or existing land uses and where the actions were originally evaluated in accordance with applicable law and regulations, and surrounding circumstances have not changed."

Environmental Considerations - reference

The plan for this mission is to fire the Hall thruster in the opposite direction of motion of the satellite. This means the ions will be traveling at the orbital speed of 7 km/s PLUS [redacted]km/s ion exit velocity = [redacted]**km/s total speed** which exceeds the **Earth's escape velocity of about 11 km/s**.

So the majority of ions will be leaving the earth forever.